Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Establishment of an Interference Temperature	)	ET Docket No. 03-237
Metric to Quantify and Manage Interference and	)	
to Expand Available Unlicensed Operation in	)	
Certain Fixed, Mobile and Satellite Frequency	)	
Bands	)	

<u>Via the ECFS</u>

COMMENTS OF THE WI-FI ALLIANCE

The Wi-Fi Alliance, ("the Alliance")[1] hereby respectfully submits its comments in the above-captioned Proceeding. The Alliance applauds and fully supports the underlying goals of the Commission in the instant Proceeding – to modernize and simplify regulatory paradigms and thereby make spectrum more accessible for both licensed and unlicensed uses. New wireless technologies require more spectrum to be made available. In addition, these technologies are decentralizing the ownership of wireless systems. In this environment, a review of spectrum management as it relates to interference protection is a logical and useful step.

[1] The Wi-Fi Alliance, formerly known as the Wireless Ethernet Compatibility Alliance, is an international trade association formed in 1999 with the goal of promoting the adoption and commercialization of IEEE 802.11-compatible products. These products may be used to support Wireless Local Area Networks in the 5 GHz frequency band. Membership in the Alliance is open to all companies that support the IEEE 802.11x standards. Current members include nearly every major radio manufacturer that produces wireless network equipment for the U.S. market. Alliance membership, with over 200 companies, continues to grow. A complete membership listing may be found on our website, http://www.wi-fi.org.

The Alliance recognizes the forward looking nature of the instant proceeding and its objective of making more efficient use of spectrum at all frequencies. However, after reviewing the Commission's proposals, the Alliance has concluded that the proposed "interference temperature" metric will not be broadly practical and applicable, and respectfully submits that the high level objective of increased spectrum efficiency and access to spectrum may be met through the use of other techniques such those identified I the Commission's Cognitive Radio Proceeding.

INTRODUCTION

1. On November 15, 2003, the Commission adopted the instant NOI and NPRM ("the NPRM") regarding the establishment of an interference temperature metric for "quantifying and managing interference." [2] The Commission continues:

> *"This new approach could provide radio service licensees with greater certainty regarding the maximum permissible interference, and greater protections against harmful interference that could be present in the frequency bands in which they operate. In addition, to the extent that the interference temperature limit in a band is not reached, there could be opportunities for other transmitters, whether licensed or unlicensed, to operate in the band at higher power levels than are currently authorized."* [3]

2. The Alliance fully agrees with the objective of protecting incumbents while allowing the spectrum in which they operate to be used by other, unlicensed, systems.

3. Current practice of spectrum sharing analysis and deciding sharing mechanisms is largely based on a model that focuses on the protection of large investments made in infrastructure, commercial or governmental. New wireless technologies require more spectrum to be made available. In addition, these technologies are decentralizing the ownership of wireless systems.

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[2] S*ee* the NPRM, at 1
[3] *Id.*, at 1

4. In this environment, a review of spectrum management as it relates to interference protection is a logical and useful step. The Commission, in recognizing this change of affairs, has put forward some truly revolutionary ways of thinking about radio interference in an attempt to provide users with the tools to locate and use available – rather than pre-allocated – spectrum.

5. Both the instant proceeding and the proceeding on “Cognitive Radio” are examples of such high level concepts, but we believe that the interference temperature concept presents problems in terms of broad applicability and practical implementation. Various combinations of cognitive radio approaches may offer considerably more potential in terms of providing practical means of achieving the Commission’s goals of increased spectrum efficiency and access to spectrum.

<u>THE ALLIANCE DOUBTS THE BROAD APPLICABILITY OF THE PROPOSED INTERFERENCE METRIC</u>

6. Analysis of propagation effects and the need to accommodate a variety of usage and deployment, along with the need to assure an adequate margin of protection to the incumbent users, suggests that the benefits of a broad measure like interference temperature are limited to cases where large scale aggregates determine the interference. One such example is RLAN interference into satellite based receivers or into the backlobes and sidelobes of radar systems (See Annex 1, attached).

7. In cases dominated by interference from a limited number of sources – e.g., interference from an RFID transmitter into a broadcast receiver, local propagation conditions vary so much that measuring the noise level at any given point does not provide reliable information about the observed noise level at a nearby point. Therefore, sharing between systems with different levels of regulatory status (e.g., newcomers that have to live together with - *and protect* - incumbents) necessarily has to be based on protection criteria and their application to a specific, incumbent service with the objective of protecting it from interference.

WOULD THE IMPLEMENTATION OF THE NEW METRIC PROVIDE REAL, PRACTICAL BENEFITS?

8. Interference temperature as a measure and control mechanism is described as little short of revolutionary. The consequences of introducing it on a large scale are likewise little short of revolutionary in their impact on systems design, deployment, provisioning, and management. It would imply an enormous change in the way interference is detected, communicated, and acted upon. This would, in turn have profound impact on equipment design and cost, leading to increased outlays by operators and individual users alike. Operational consequences would include much higher demands on network management resources and therefore higher operating costs. Even assuming that the underlying technical issues could be solved, the Alliance would strongly recommend that the Commission carefully analyze the cost of a major change on transmitting systems design in relation to the expected benefits.

WE BELIEVE THE COMMISSION SHOULD FOCUS ON PERMITTING ADDITIONAL LICENSED AND UNLICENSED OPERATIONS IN SPECTRUM SEGMENTS WHICH ARE ALLOCATED BUT UNUSED

9. The Alliance believes that there are significant parts of spectrum which are assigned to licensed operations, but are partially unused because of geographic, economic, or operational considerations. We note that this spectrum represents "low hanging fruit" which could be harvested within the present regulatory framework, independent of the long term status or implementation of the interference temperature concept.

10. For example, the Commission, in its NOI ET 02-380, *Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, already recognizes that such fallow spectrum exists and might be exploited under the present regulatory regime, stating *"Specifically, we seek comment*

on the feasibility of allowing unlicensed devices to operate in TV broadcast spectrum at locations and times when spectrum is not being used…."[4]

11. We urge the Commission to give priority to pursuing regulatory activity which identifies and opens fallow spectrum to use by licensed and unlicensed operations. We believe that such regulatory activity can begin now. The identification and utilization of such existing spectrum opportunities is a fast track to redeveloping currently underutilized spectrum segments, and we reiterate our belief that the Commission's Proceeding on "Cognitive Radio"[5] shows much promise from this point of view.

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[4] See ET 02-380, at 1.
[5] *See* ET 03-108

CONCLUSION

12. We encourage the Commission to continue to explore innovative regulatory avenues which would increase the opportunity for new technologies to increase spectrum utilization, enable new avenues of economic growth, and a new era of advanced services for consumers.

13. Since the availability of unlicensed spectrum continues to be an enabler of this process, we encourage the Commission to pursue every opportunity to open up more spectrum to unlicensed uses, while assuring that incumbent licensees receive the protection to which they are entitled.

14. In summary, while we strongly support the underlying goals of the instant proceeding to increase both efficiency of spectrum utilization and access to spectrum, we urge the Commission to proceed with the utmost of caution, if at all, with even limited implementation of the interference temperature approach and we point to the Cognitive Radio Proceeding as a more likely means of realizing some of these goals more practically and in a more timely manner.

Respectfully submitted,

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Annex 1

Analysis of the use of interference measurements for the purpose of dynamic sharing decision making

This Annex looks at three sharing cases and analyzes if interference measurement can be effective as a tool for making actual, real time sharing decisions

First case: Satellite based System and RLANs

The Mobile Satellite Service, the Fixed Satellite Service and the Earth Exploration Satellite Service are three examples of potential incumbent systems that see large area populated by many interfering transmitters. The large numbers involved mean that the statistics of the interfering signals are likely to be very flat – and thus the overall interference is very much like “noise.” Measuring this noise level and broadcasting it to the interferers so as to prevent them from transmitting when the “noise” gets to high, creates a problem for the receivers of this signal: when there are ten of millions of devices, the correlation between the activity of a particular interferer and the noise at the satellite is lost and thus this noise level is not suitable for making local transmit decisions.

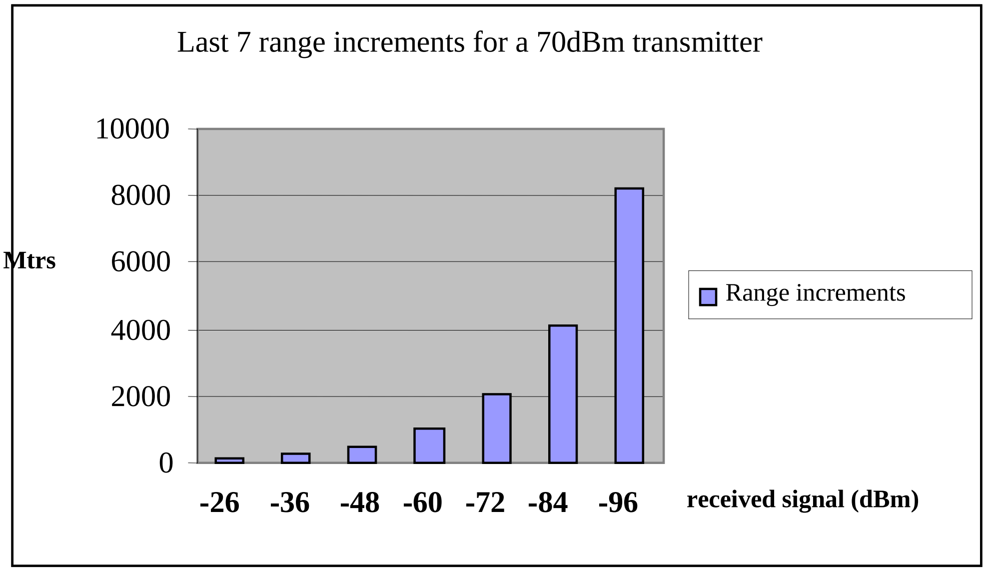
In principle, interference temperature as a regulatory tool works for sharing between devices like RLANs and satellite receivers. However, the observed noise level at the satellite could only be used to control the entry of new devices into the market, not to control particular transmitter activity in real time.

Second case: co-located terrestrial systems

The single most important factor in determining the suitability of a sharing metric is the separation distances it would create. Short separation distances mean many opportunities for sharing spectrum; large separation distances mean few opportunities for sharing spectrum.
In order to understand the implications of using interference measurements in determining actual sharing, it is instructive to look at how signal strength varies with distance.

The graph below shows how range varies with signal strength for some hypothetical licensed system that operates at 70dBm and has a minimum useful sensitivity of -96 dBm[6] at its design data rate. This gives an operating range of ~16km under typical path loss conditions (d^4 or 12dB/octave).

[6] For 2.6 GHz, pathloss exponents 2, 3, and 4, breakpoints at 64m and 512m

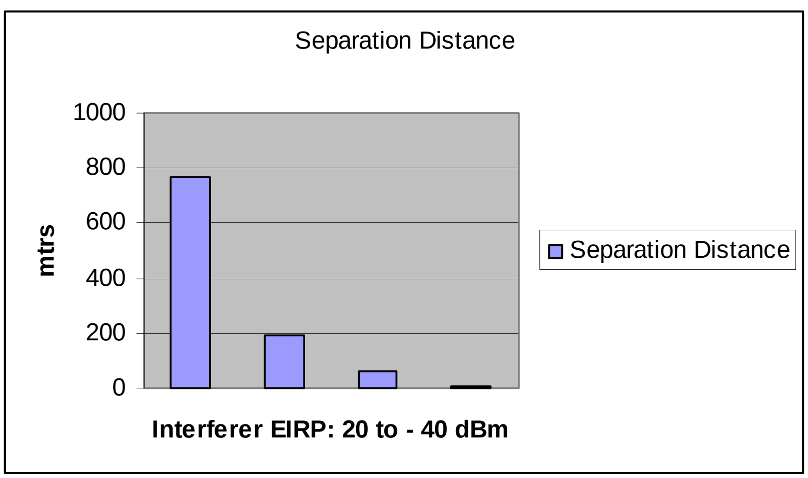


This graph shows that the final range increments for the licensed system are very large: the final range increment of the protected system for a 12dB signal drop is 8296 meters.

Assume that the interferer is required to protect the incumbent system by assuring that the SIR of the incumbent is maintained. In other words, the interference signal strength should be 12dB below that of the wanted signal of any receiver of the licensed system. If we add a 10 dB uncertainty margin, the interferer's power should not exceed -74 dBm. That signal strength corresponds to about 1/4th of the range of the licensed system. This corresponds to 6.6% of its coverage. In other words, the gain in "operating area" for unlicensed systems is negligible.

EIRP of the interferer

If we know the acceptable level of interference at the licensed receiver, we can calculate the EIRP of the interferer for some separation distance. The table below gives the separation distances for an interferer of the same bandwidth as the protected system for a number of power output values of the interferer.



If the interferer has to protect incumbents up to 64 meters away, its EIRP can no be more than -20dBm. Said differently, to operate at a meaningful power level, e.g., +20dBm, interfering systems have to be separated by about 800 m from the licensed receivers. This reduces the range in which interfering systems could operate from 4000m to 3200m from the licensed transmitter. This amounts to 4% in terms of coverage of the interfering system.

The conclusion of is that for similar systems, a reasonable protection margin (= interference temperature) for a typical licensed incumbent system results in a very small, if not useless, improvement in operating range for interfering systems.

These observations hold for many cases where the differences in signal bandwidth of incumbent and interferer are similar and differ less than a factor 4. When the differences become large – e.g., the bandwidth of the incumbent is much less than that of the interferer, the required protection distances are correspondingly reduced. An extreme case is ultra wideband modulation: here the interference distance becomes minimal but, as studies have shown, it does not become zero.

Ignoring the question of benefit to be expected from the use of a generic protection margin, one has to ask the question of feasibility. Any local measurement of interference level says very little about the interference conditions at a receiver at some distance away. The larger the protection distance that must be observed by the interferer, the less accurate the correspondence between the "noise" caused by the interferer and the real noise level at the incumbent. The culprit is the highly exponential path loss that destroys the "distance" information contained in an RF signal.

Therefore, a sprinkling of low power devices – like RLANs – will create an interference landscape that looks that a miniature mountain range. The receiver of the incumbent system can survive in the valleys but it may not survive at higher levels. Even if we ignore that the mountain range changes over time as users change location and activity, it will be clear that taking the average altitude of such a landscape as reference for spectrum access decisions will not protect any incumbent system.

Third case: Fixed Links and RLANs

Fixed link systems typically use full duplex channel arrangements and high gain antennas to achieve their range.

The antenna pattern is therefore pronounced and this plays a major role in (localizing) interference sensitivity. Ignoring the antenna side- and back-lobes, the interference from RLANS seen in the main beam of the antenna will be spotty in time and amplitude: RLAN activity is bursty and RLANs close by will cause much more interference than distant RLANs. In addition, the RLANS themselves live in a "mountain range" world, in which they are largely isolated from each other – and sometimes from their incumbents as well. Therefore, measuring RLAN-caused interference to control transmission by individual RLANs does not work – not even when the FS is a TTD system.

Note on DFS to protect incumbent services

The DFS mechanism conceived to protect radar systems operating in the UNII band from RLAN interference works for the protection of fixed links only when those links operate in TTD fashion.

In that case, the presence of a signal can be used by the interferer to switch channels. The underlying assumption is that the interferer will be able to differentiate between signal of its own kind and the fixed links' signal – and this may not be easy when a variety of modulation schemes are being used in such links.

In FDD systems, the DFS mechanism fails: detecting one signal says little about the ability of the fixed link receiver to correctly receive the intended signal. In fact, if there is any relationship at all, it is inverse: The stronger that fixed link signal is, the less likely is the interference potential of the device detecting that signal.

Implementation Issues

Even if one assumes that the coordination distances required for interference temperature based sharing are acceptable, there remain implementation issues. First of all there is the problem of reliable detection of low level interference signals against the backdrop of other spectrum usage. The required detection level is close to or below the minimum useful sensitivity of the system to be protected. The unlicensed devices would need a costly receiver to reliably and accurately detect such signals. In any case, the accuracy of such a low level receiver would be questionable any way since small local variations in the propagation conditions would cause large fluctuations in the detected signal.

The second major problem with the implementation is the certification. If the signal levels to be detected are so low, the measurement uncertainty is correspondingly high and this would make certification de facto impossible - the measurement uncertainty would result in a wide margin of error in the behaviour of certified systems in the field. This would be unacceptable to the protected users of a given spectrum area.

Conclusion

The quest for improved means to share spectrum efficiently remains of great interest and the FCC has taken a bold step in proposing the interference temperature metric to be used as spectrum sharing mechanism. This metric may have some merit when applied to cases dominated by large numbers of interferers into one type of system or service. However, notwithstanding its lofty goal, the metric falls short of its intended purpose when applied to terrestrial sharing regimes.